

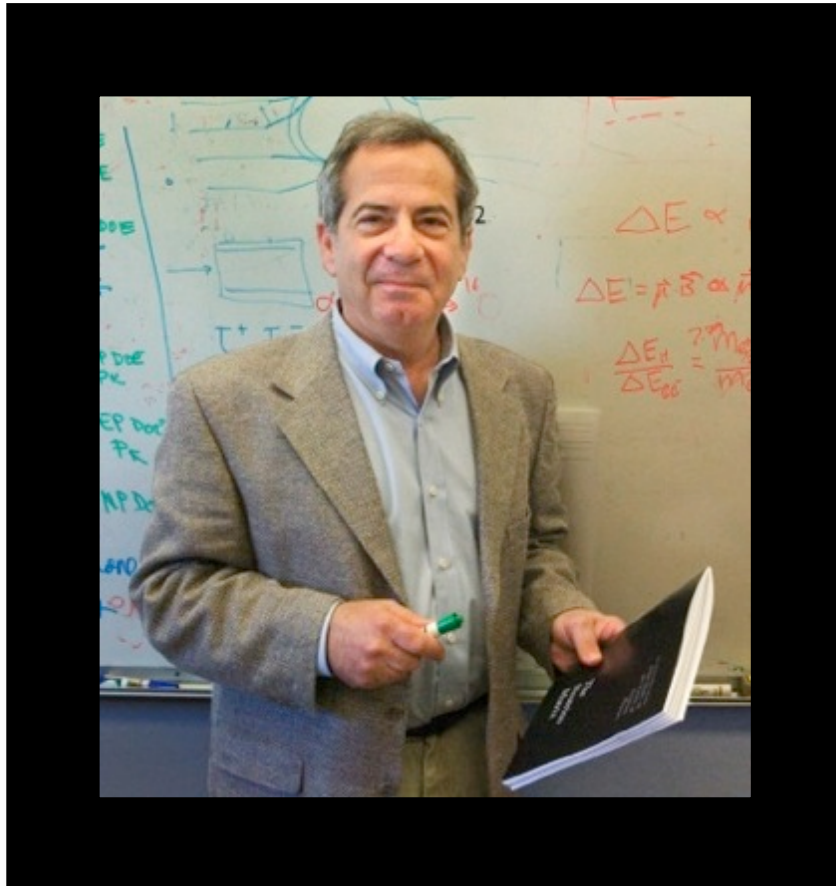
Nuclear Science Division Newsletter

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November, 2012

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Stuart J. Freedman, 1944-2012

NSD senior scientist and UC Berkeley Physics Professor **Stuart Jay Freedman** passed away unexpectedly on November 9, while attending a scientific meeting in Santa Fe, New Mexico. Stuart was a major figure, both here and in the national nuclear science program. He will be greatly missed. For more about his life, click link below:

<http://newscenter.lbl.gov/news-releases/2012/11/16/in-memoriam-stuart-freedman-renowned-nuclear-physicist/>

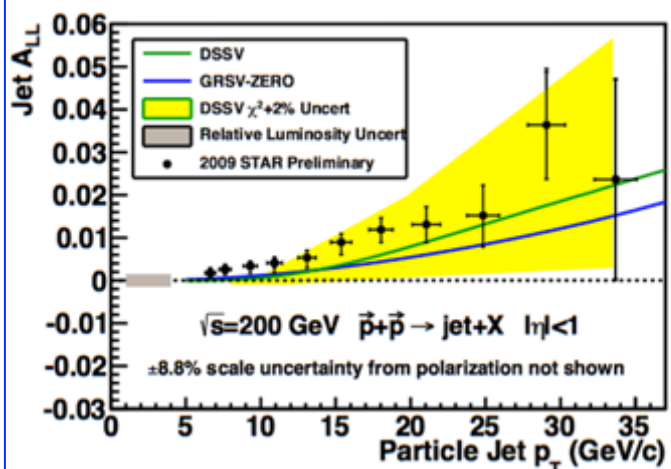
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STAR jets probe the proton spin

The pursuit of the proton spin composition in terms of its quark and gluon constituents with the STAR experiment is motivated by unexpected results from polarized deep-inelastic lepton-nucleon scattering experiments. These experiments found that quark and anti-quark spins combined constitute only a non-

intuitively small fraction of ~20% of the proton spin. This contribution is in striking contrast with expectations from constituent quark models, which enjoyed success in describing hadron magnetic moments and spectroscopy.

A key question is how gluon spins contribute to the proton spin? The gluon spin contribution has the remarkable property, related to the axial anomaly of the theory of strong interaction (QCD), that it increases with scale in inverse relation to the strong coupling constant. A non-zero contribution will thus give rise at large scales to compensating orbital momenta -- all in a ground-state system!



STAR data on the beam-spin asymmetry ALL in jet production in 200 GeV polarized proton-proton collisions, in comparison with two prior QCD analyses with small gluon polarization.

spin dependence in the production rates of inclusive jets in longitudinally polarized proton-proton collisions at a center of mass energy of 200 GeV. The data, shown as the beam-spin asymmetry ALL versus jet transverse momentum p_T , are dominated by quark-gluon hard scattering contributions and exhibit a distinctly positive trend. QCD analysis of world data quantifies the gluon spin contribution to be ~20% of the proton spin at a typical scale of 10 GeV² for gluons that carry 5-20% of the proton momentum, with an uncertainty of about half its size.

The NSD spin-physics group was integral to the development of the jet analysis in STAR and the normalization of the data. It is preparing for 500 GeV measurements in 2013 and, in close collaboration with NSD theorists, is developing the science case for an electron-ion collider to further unravel the proton spin.

STAR data now have the precision to reveal gluon spin preferences in the (polarized) proton. The experiment measured beam-

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Electron Tracks Improve X-ray imaging

Gamma-ray imaging plays an important role in both basic science and applications such as national security or medical imaging. Compton-scatter or Compton imaging provides high sensitivity and good resolution for a large range of gamma-ray energies, as long as the Compton scattering is the dominating interaction process. Recently, high-resolution, semiconductor-based instruments have been built for applications in astrophysics and nuclear security. However, as these instruments cannot directly measure the initial direction of the Compton-scatter induced electron, the incident gamma-ray direction can only be constrained to a conical surface. This limits the achievable image contrast (signal-to-noise ratio), as is shown in the figure. Measuring the initial direction of the electron enables the reduction of the cone to an arc, potentially leading to a significant increase in the achievable contrast, limited only by the ability to reconstruct the initial part of the electron track. NSD's Applied Nuclear Physics program recently demonstrated – for the first time - the ability to reconstruct electron tracks and to perform electron-tracking-based Compton imaging in semiconductor detectors and have defined a development path towards an instrument based on high-resolution scientific CCD systems. We have implemented one fully depleted CCD detector with 650 μm thickness and 10 μm pixel size in combination with a 3D position sensitive double-sided Ge detector. Algorithms were developed to determine the initial scatter direction in three dimensions. The algorithm faced two challenges: the random-walk character of these electrons and limitations of the two-dimensional projection of the three dimensional track.

In order to provide real-time imaging and event-by-event reconstruction we are developing so-called CCD-Strip detectors with the non-pixelated side implemented as Si-strip detector. The timing and energy information from the prompt strip signals can be used to tag electron tracks within a CCD image for the proper, event-by-event gamma-ray reconstruction.

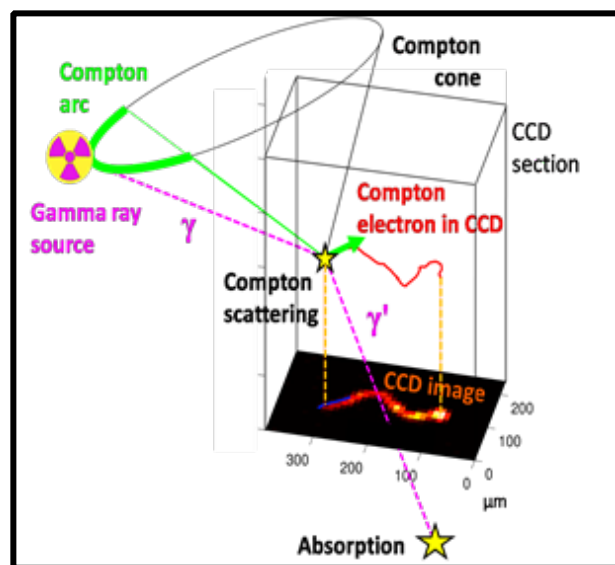
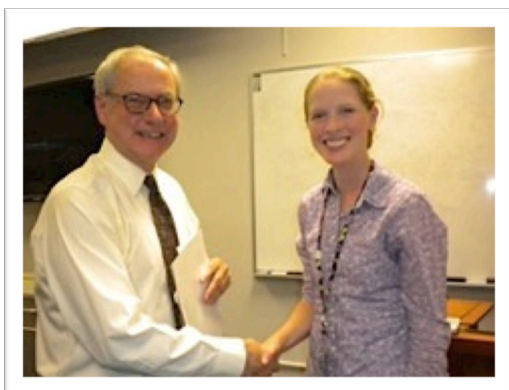


Illustration of electron-tracking based Compton imaging employing a high-resolution CCD system. A Compton arc can be deduced if the incident 3D electron-scatter direction can be obtained resulting in significantly increased image contrast and signal-to-noise ratios.

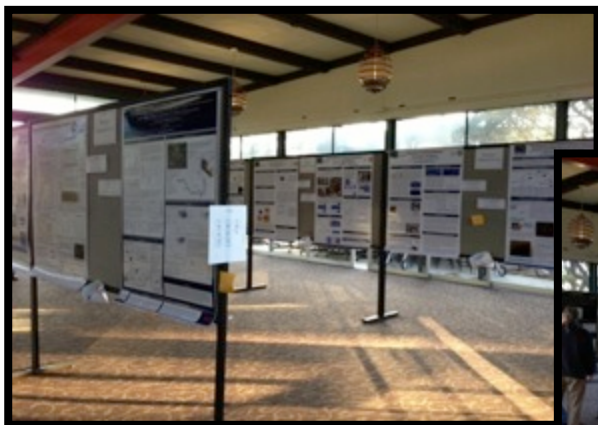
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NSD Fragments

At our November 5 Monday morning meeting, the NSD honored two graduate students for their contributions to safety. **Erin Gantz** (*below, left with James Symons*), and **Sandy Miarecki** (*below, right*) received awards for their contributions to the safety environment in the division. Sandy received her award for contacting the shipper of Samarium foil in order to determine the owner when she discovered the packaged foil in recycled packing peanuts. Erin received her award for being a safe worker and for promoting safety in the laboratory where she works. Congratulations Sandy and Erin!



The NSD Director's Review was held onsite November 26-28. This review, commissioned by the laboratory management once every three years, reviews all aspects of the NSD. This review featured something new: a poster session which allowed the younger members of the division to present their work to the committee. The photos shows some of the 36 posters awaiting the arrival of the committee.





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Newsletter Notes

Please send any comments, including story suggestions to Spencer Klein at: srklein@lbl.gov.

Previous issues of the newsletter are available at:

<https://commons.lbl.gov/display/nsd/NSD+Newsletter+Archives>

Newsletter layout of current and previous issues by S. Ritterbusch